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published in
Journal of Abnormal Child Psychology
2002

DOI (link to publisher)
10.1023/A:1019816930615

document version
Publisher's PDF, also known as Version of record

Journal of Abnormal Child Psychology, Vol. 30, No. 5, October 2002, pp. 477–486 (© 2002)

Serious Delinquent Behavior, Sensation Seeking, and Electrodermal Arousal

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Received April 30, 2001; revision received December 5, 2001; accepted February 11, 2002

Low tonic skin conductance level (SCL) has been related, inconsistently, to both delinquency and sensation-seeking. This study tests the hypothesis that there is an interaction such that high sensation seeking delinquents, in particular, have low SCLs. Participants consisted of 335 boys from the Pittsburgh Youth Study classified as serious delinquents or controls based upon 10 years of prospectively collected self-report delinquency data. Participants' skin conductance was evaluated at age 16 along with several personality and neuropsychological measures. Both delinquency and sensation seeking were characterized by low SCL. However, there was no evidence to suggest that the presence of both of these factors together lead to especially low skin conductance levels. This finding is not explained by differences between the groups on measures of negative emotionality, IQ, socioeconomic status, or impulsivity.

KEY WORDS: recidivists; skin conductance; antisocial; stimulation-seeking; arousal.

Low electrodermal arousal has been observed as a feature of antisocial or aggressive persons (Gilbert, Gilbert, Johnson, & McColloch, 1991; Lahey, McBurnett, Loeber, & Hart 1995; Raine 1993). Some researchers have demonstrated low electrodermal activity to prospectively predict later antisocial outcome, thus suggesting a possible causal role for this physiological process (Kruesi et al., 1992; Loeb & Mednick, 1977; Raine, Venables, & Williams, 1990). However, findings for resting skin conductance levels (SCL) have been inconsistent in their relationship to antisocial behavior (Lahey et al., 1995; Scarpa & Raine, 1997). This may be due in part to the fact that many studies have dealt with small group sizes and have varied in the way they define antisocial behavior. Despite these inconsistencies however, Lahey et al. (1995) suggest that skin conductance remains an important correlate of "severe and persistent" forms of antisocial behavior and deserves further study. The present study examines resting skin conductance in 139 serious delinquent adolescents to determine if and how low resting skin conductance relates to delinquent behavior.

Another trait suggested to be related to low levels of arousal is sensation seeking (Ellis, 1987; Farley & Farley, 1972; McNamara & Ballard, 1999). The original sensation seeking scale was developed in order to measure individual differences in optimal arousal levels (Zuckerman, Kolin, Price, & Zoob, 1964). It is believed that individual differences in arousal levels influence the behavior of individuals to seek or avoid sensation as necessary to maintain an optimal level of arousal (Kohn, 1987). Thus, individuals high in sensation seeking would be expected to show a reduced level of skin conductance arousal during rest. This relationship was demonstrated by Plouffe and Stelmack (1986), who found a negative correlation between sensation seeking and skin conductance level in young females. Although not directly measuring sensation seeking, introverts (presumably low in sensation seeking) have been shown to reach their optimal level of arousal earlier than extroverts (presumably higher in sensation seeking;

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Smith, 1983) and extroverts have shown lower skin conductance levels than introverts regardless of experimental condition (Smith, Rockwell-Tischer, & Davidson, 1986). However, findings relating low skin conductance levels and sensation seeking have been particularly equivocal when measured at rest.

Sensation seeking and antisocial behavior have also been related to each other (Blackburn, 1978; Ellis, 1987; Farley & Farley, 1972). In an early but influential theoretical analysis, Quay (1965) developed the hypothesis that low arousal may lead to pathological sensation seeking behavior that may increase the probability of antisocial tendencies. Just as low arousal has been shown to be predictive of later antisocial offending, sensation seeking as early as age 3 was predictive of aggression at age 11, suggesting that sensation seeking could predispose to antisocial behavior (Raine, Reynolds, Venables, Mednick, & Farrington, 1998). Given the equivocal relationship, both sensation seeking and antisocial behavior have with skin conductance arousal, it is possible that it is actually their relationship with each other (i.e. their interaction) that particularly relates to low SCL. It is hypothesized, therefore, that low skin conductance arousal is present in those individuals who are both antisocial and high sensation seeking, thus explaining the inconsistent findings when examining either trait alone.

Skin conductance levels have been reported to be an appropriate and valid indicator of general arousal during times of low to moderate arousal (such as would be considered during periods of rest; Boucsein, 1992). Furthermore, Smith (1983) cites evidence that tonic SCL may be a more direct measure of arousal than phasic measures, which may be more complex functions of arousal and attention. However, theories of general arousal have been replaced with more complex theories of arousal functions and differing arousal systems. One such system, the mesolimbic and mesocortical dopamine system of the brain has been related to the general activation of motivated behavior and thus is hypothesized to relate most directly to sensation seeking behavior (Bardo, Donohew, & Harrington, 1996; Robbins, 1997; Zuckerman, 1994). Skin conductance should be a reasonable measure of arousal as it appears to relate to the dopaminergic arousal functions that may be dysregulated in sensation seekers (Davidson & Smith, 1989; Stoner, Skirboll, Sidney, & Hommer, 1988).

In exploring the relationship between sensation seeking and delinquent behavior, it is important not only to consider biological phenomenon such as arousal but also to attend to psychosocial factors that influence the expression of these characteristics. Despite the observed relationship between sensation seeking and antisocial behavior, it is also clear that sensation seeking does not necessarily result in an antisocial outcome. Sensation seeking can be seen in nonantisocial persons who choose high risk sports or professions as well as many other socially acceptable outlets of this trait (Goma, Perez, & Torrubia, 1988; Zuckerman, 1983). One theory has proposed that social variables, such as socioeconomic status, strongly influence the outcome of sensation seeking into antisocial versus prosocial behaviors (Farley & Sewell, 1976). Thus, individuals with few environmental and social resources may be more likely to express their sensation seeking in antisocial ways than someone with more opportunity for a prosocial outcome. This result was also found for another risk factor, impulsivity, where impulsive boys were at greatest risk for delinquent behavior when they came from poor neighborhoods (Lynam et al., 2000), suggesting that low SES may be an important factor in how risk variables are expressed. Recent research has identified a number of variables that serve as both protective and risk factors (depending on the strength of their presence or absence) for antisocial behavior (Stouthamer-Loeber et al., 1993). Among those commonly found are IQ and impulsivity (Kandel et al., 1988; Lynam, Moffitt, & Stouthamer-Loeber, 1993; White et al., 1994, White, Moffitt, & Silva, 1989). Socioeconomic status, while important, may not be the only influencing variable in the prosocial versus antisocial outcome of sensation seeking behavior.

Past research on both sensation seeking and antisocial behavior may have been inconsistent in finding reduced resting skin conductance arousal perhaps because it is the subgroup of sensation seeking delinquent offenders specifically who are low on arousal. This study hypothesized that there is an interaction between sensation seeking and delinquent behavior such that it is specifically delinquent individuals who are high in sensation seeking that are low on electrodermal arousal. It is also hypothesized that the relationship between sensation seeking and delinquency may be influenced by psychosocial factors such as socioeconomic status, IQ, and impulsivity.

METHODS

Participants

Participants for this study consisted of the youngest of three samples making up the Pittsburgh Youth Study. Full details of participant characteristics and data collection have been published previously (Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998). Briefly, 868 boys were first recruited as first graders in the spring of 1987. Participants were screened and 250 boys with the

highest risk of antisocial behavior were selected. Two hundred and fifty three additional boys were randomly selected from the remaining, low antisocial, participants bringing the total number of participants to 503. Of the original sample, 335 (66.6%) participated in the current study assessing biosocial bases of antisocial behavior and involving a psychophysiological assessment. The loss of 168 participants over the 10-year interval between recruitment and the current study was due to the following reasons: 31 moved away from the area, 20 were in jail, 45 refused continued participation in the Pittsburgh Youth Study, and 35 refused participation in the biosocial component of the larger study. An additional 37 participants were lost after they repeatedly canceled or failed to make appointments. Comparisons between participants and nonparticipants on data collected at age 7 revealed the following odds ratios, which were all nonsignificant: socioeconomic status (odds ratio 0.99), ethnicity (African American vs. White: 1.15), initial risk status (1.09), delinquency seriousness (no or minor delinquency vs. moderate or serious delinquency: 0.83), and violence seriousness (no violence vs. gang fighting and attacks: 0.87). Results did not provide support for selective attrition. Three hundred and thirty five participants participated in this study. Because of random errors in computer recording, or loss during data transfer, 32 of these participants had data missing from one or more of the measures critical to the analyses presented in this paper (skin conductance at rest or sensation seeking scores). The remaining 303 participants had a mean age of 15.67 ($SD = 0.95$). Of these participants, 41.2% were Caucasian and 58.8% were African American.

Initial follow-ups were done at 6-month intervals until age 11 at which point assessments were made at 1-year intervals. During these follow-ups, participants, teachers, and parents were asked to report on antisocial behavior of the participant. Fifteen assessments were made in the 10-year period from initial screening to the time when autonomic nervous system (ANS) measures were taken at approximately age 16.

Measurements

Delinquency

This study offers a unique advantage of assessing delinquent behavior prospectively over many years in order to get an accurate picture of the participants' pattern of offending. During each of the assessments multiple forms of delinquency measures were taken to document participants' delinquent history throughout the course of the study. Each participant was given the Self-Report Delinquency (SRD) form at each assessment phase (Elliot, Huizinga, & Ageton, 1985). However, for the first few assessments this form was modified to the Self Report Antisocial (SRA) Behavior Scale because of the concern that the antisocial behavior represented in the SRD may be too sophisticated for the younger participants to understand (Loeber, Stouthamer-Loeber, Van Kammen, & Farrington, 1989). In addition, parents and teachers were asked to fill out their respective report forms of the Child Behavior Checklist (CBCL; Achenbach, 1991a, 1991b, 1991c). Items from the parent, teacher, and child self-report form were used to construct delinquency categories that represented severity and type of behavior. Categories were constructed to represent minor (at home), minor (other), moderate, and serious delinquency and a separate category for serious violent delinquency (see Table I for a list of items in each category). Participants were classified into the highest category for which they met criteria in the period between the prior assessment and the current assessment.

A control group and a serious delinquent group were created. Dichotomization of the variable was chosen instead of a continuous count of antisocial behavior because dichotomization has been shown to be an effective approach in this type of research by avoiding problems that commonly occur with psychological variables such as nonnormal distribution, noninterval scales, and scales with small ranges that should not be classified as truly continuous. Furthermore, research on antisocial behavior has suggested that median split dichotomization has the highest correlation with continuous variables and thus is not likely to change the conclusions drawn from the results (Farrington & Loeber, 2000). Dichotomized variables also facilitate the interpretation of interactions.

Only moderate to serious delinquency, defined as levels 3 through 5, was used to construct these groups. In order to obtain only serious delinquent offenders, participants must have had at least three occasions of delinquent behavior across the 15 assessment phases. This definition is consistent with previous research on persistent offenders (Blumstein, Farrington, & Moitra, 1985) and was used to ensure that only serious delinquents were included in the classification. Because the psychophysiological measures were taken at age 16, a further requirement was that at least one of the qualifying assessments must have fallen in the last phase of data collection defined as the final three assessments (ages 15, 16, and 17). This was meant to avoid inclusion of any childhood-limited offenders and to more clearly relate the antisocial behavior to the current psychophysiological functioning. Controls could not have any incidents of moderate, serious, or

Table I. Categories of Antisocial Behavior

Levels	Specific items and reporting source		
	SRD	CBCL parent	CBCL teacher
Level 1: Minor delinquency (at home)	Damaged or destroyed property at home Stolen $5 or less at home	Steals at home	
Level 2: Minor delinquency (other)	Damaged or destroyed property outside home Set fire (no or minor damage) Avoided paying for something Stolen $5 or less outside of home Shoplift Sold worthless goods	Vandalism Sets fire (no or minor damage) Shoplifts Steals outside home Steals at school	Vandalism Sets fire (no or minor damage)
Level 3: Moderate serious delinquency	Damaged or destroyed property Set fire (major damage) Illegal checks Credit card fraud Carried a hidden weapon Stolen between $5 and $50 Stolen between $50 and $100 Stolen something greater than $100 Snatched purse or picked someone's pocket Stole from a car Fencing Gone joyriding Gang fight	Steal bike Take vehicle without permission Gang fight Carry weapon	
Level 4: Serious delinquency	Break and enter Stole car Prostitution Sold marijuana Sold hard drugs such as heroin, cocaine, or LSD	Sells drugs	
Level 5: Serious violent delinquency	Attack with weapon Strong-arm methods to get money or things from people Hurt for sex Forced sex		Strong arm

violent delinquency at any phase in the 15 assessments. Of the available 303 participants, 66 met criteria as controls (37 Caucasian, 29 African American), while 139 met criteria as serious delinquent offenders (43 Caucasian, 96 African American). Results of a Pearson chi-square analysis indicate a significant difference between groups on race $\chi^2(1, 205) = 11.87$, $p = .001$. Because of the significant group difference, race was entered as a covariate in all analyses.

Sensation Seeking and Impulsivity

Sensation seeking was measured with the Impulsive Sensation Seeking Scale of the Zuckerman–Kuhlman Personality Questionnaire (ZKPQ; Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993). The 19 items were divided into impulsivity and sensation seeking subscales, as suggested in Zuckerman (1994, p. 46) in order to examine sensation seeking and impulsivity separately as specific risk factors for antisocial sensation seeking. These scales are thought to be correlated, but were only modestly correlated in this sample ($r = .351$). This instrument was administered at age 16 following the psychophysiological assessment.

Groups were split into high and low sensation seeking categories based on a median split of the sample for the same reasons given above for the grouping of delinquent participants. Responses ranged from 1 to 10 with a median of 6. Participants with a score of 6 or higher were labeled as

high sensation seekers ($n = 128$) whereas those scoring 5 and below were labeled as low sensation seekers ($n = 77$).

IQ

Participants were administered the WISC-III on the afternoon of the same day on which the psychophysiological and personality assessments were made (Wechsler, 1991). Each of the following subscales was included: Vocabulary, Information, Block Design, and Picture Completion. Estimates of Verbal IQ, Performance IQ, and Total IQ were computed from the subscales.

Sociodemographic Measures

Socioeconomic status was computed using the Hollingshead (1975) index. Occupational status was weighted by 5 and education level was weighted by 3. The highest score for all family members was used. These measures were assessed at the first follow-up of the participants.

Negative Emotionality

In order to explore the possibility that high skin conductance values can be explained by state anxiety, participants were administered the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988), after undergoing the electrode application and immediately prior to beginning data collection for the initial rest period. This scale has been shown to have a significant positive correlation with the State Anxiety Scale ($r = .51$) and to be related to other measures of negative emotionality (Watson et al., 1988). State anxiety may have a more immediate and identifiable relationship to skin conductance measures than trait anxiety (Neary & Zuckerman, 1976). The degree to which each participant experienced each emotion at the time of measurement was summed across all items on the negative affect scale and entered as the dependent variable.

Skin Conductance

Participants were assessed during a 3-min rest period at the beginning of the study (Rest 1) and again at the end when all tasks had been completed (Rest 2). The tasks in between each rest period consisted of an orienting task, an oddball task, a social stressor, a physical stressor, and the continuous performance task. The final rest period, Rest 2, followed the continuous performance task, which involved watching a screen with continually flashing numbers and pressing a button to the target number. Because of the time involved in giving instructions, conducting the practice trials, administering the task itself, and collecting saliva samples, which were taken periodically for another study, the final rest was separated from the last stressor task by approximately 15 min. Participants were tested in a light and sound attenuated room adjacent to the room containing the psychophysiological recording equipment. All participants were tested in the morning between 9:30 and 11:00 a.m. in order to standardize time of day of testing. Participants were seated comfortably in a chair, while temperature in the room was controlled with the thermostat set at 72°F.

Sensorimedics Ag/AgCl 0.9-cm electrodes were placed on the distal phalanges of the first and second fingers of the participants' nondominant hand and fixed in place with adhesive tape, while area of skin in contact with the electrode was delineated with Med Associates electrode collars with a 0.45-cm diameter hole. Skin conductance was measured at distal phalange sites in accordance with recommendations of Scerbo, Freedman, Raine, Dawson, and Venables (1992). Commercially available Unibase cream was combined with 0.9% physiological saline for use as the electrolyte medium (Fowles et al., 1981). A constant 0.5 V DC excitation was applied to the skin, as recommended by Fowles et al. (1981). Skin conductance was DC recorded with a low-pass filter of 20 Hz and amplified using a Colbourn skin conductance coupler (S71-22), sampled at the rate of 5 Hz and computer scored. Skin conductance levels were recorded as an average of the data during each of these two rest periods.

Analyses

A 2 × 2 × 2 (delinquency [delinquents vs. controls] × sensation seeking [high vs. low) × time [Rest 1 vs. Rest 2]) three-way repeated measures multivariate ANCOVA design was used to test the interaction between antisocial behavior and sensation seeking during rest. Average skin conductance level was entered for each of the two 3-min rest periods as the dependent measure. Sensation seeking and antisocial status were entered as factors. Race was entered as a covariate to control for its relationship with skin conductance (Anderson & McNeilly, 1991). Univariate ANCOVAs were used to assess IQ, impulsivity, and socioeconomic status between groups to address possible explanatory factors. Race was also entered as a covariate in these analyses. Analyses were conducted between delinquents and controls separately for both high and low sensation seeking level, to answer the question of which factors influence the expression of antisocial behavior among sensation seekers.

Table II. Means and Standard Deviations for Repeated Measures MANCOVA Examining the Interaction Between Delinquency Status and Sensation Seeking Over Two Test Periods, Controlling for Race

	High sensation seeking			Low sensation seeking		
Group	*M*	*SD*	*N*	*M*	*SD*	*N*
Rest 1 SCL (μs)[a]						
Controls	1.56	0.97	30	2.28	1.35	30
Serious delinquents	1.34	1.10	88	1.20	0.85	43
Rest 2 SCL (μs)[a]						
Controls	1.59	0.84	35	2.20	1.16	30
Serious delinquents	1.39	0.87	88	1.47	1.21	43

[a] Skin conductance values are reported here uncorrected for electrode size. A factor of 6.25 can be used to convert values to microsiemens/cm^2.

RESULTS

Antisocial Behavior and Sensation Seeking

No main effect or interactions for skin conductance were observed with time (all *p*s $> .12$), indicating that the groups do not differ as a function of rest period (Rest 1 (beginning] or Rest 2 [end of study]). Race was a significant covariate indicating that African American participants had lower resting skin conductance levels than Caucasian participants, $F(1, 191) = 48.98$, $p < .001$. Nevertheless, even with race entered as a covariate, there were significant between-groups main effects for the remaining variables.[5] Delinquency status was significant, indicating that serious delinquents were lower in resting skin conductance than controls, $F(1, 191) = 4.39$, $p = .037$. High sensation seekers were also significantly lower in skin conductance than low sensation seekers, $F(1, 191) = 7.46$, $p = .007$. There was also a significant antisocial group by sensation seeking interaction, $F(1, 191) = 4.80$, $p = .030$, indicating that while both antisocial groups had low electrodermal arousal, high sensation seeking controls also had low arousal. Means and standard deviations are reported in Table II. See Fig. 1 for a graphic depiction of the interaction.

Given the group difference on IQ and SES, correlations were run to determine whether or not these factors relate to skin conductance level and may possibly be influencing the findings. A significant correlation was found between IQ and SCL at Rest 1 ($r = .22$, $p = .001$) and Rest 2 ($r = .18$, $p = .008$). However, no significant correlation existed between SCL and SES for Rest 1 ($r = .06$, $p = .420$) or Rest 2 ($r = .06$, $p = .369$). IQ was then entered as a covariate in the repeated measures MANCOVA originally run to test the interaction between groups on SCL. IQ was not a significant covariate, $F(1, 187) = 0.54$, $p = .463$, and including IQ as a covariate did not change the pattern of results.

Explanatory Factors

Negative Emotionality

In examining the interaction between sensation seeking and antisocial behavior (see Fig. 1), it is evident that the only group that is truly distinctive is the low sensation seeking controls, with relatively high skin conductance levels. It is possible, therefore, that this group may be abnormally anxious, thus causing an increase in their skin conductance levels. In conditioning experiments, skin conductance levels have been shown to relate to anticipatory anxiety (Lovibond, 1992). Thus it is possible that anxiety related to the unfamiliar psychophysiological procedures induced larger skin conductance levels in the low sensation seeking control group compared to the other groups. To explore this possibility, post hoc analyses were run to determine whether or not this group was characterized by excessive negative emotionality. A 2×2 ANCOVA was used to compare the groups on the negative affect scale of the PANAS. Sensation seeking group status and antisocial group status were both entered as factors with race entered as a covariate, as in other analyses. Means and standard deviations for each group were as follows: low sensation seeking controls = 13.33 (3.02); high sensation seeking controls = 12.78 (2.37); low sensation seeking delinquents = 13.13 (3.53); high sensation seeking delinquents = 13.98 (4.01). Results indicate that

[5] Because of theoretical concerns with the use of ANCOVA, a second analysis was conducted that included race as a factor. With race entered as a factor instead of a covariate the pattern of results is essentially unchanged and race does not significantly interact with sensation seeking, delinquency, or time. Therefore, the differences between the groups do not appear to be a result of the higher number of African Americans in the delinquency group.

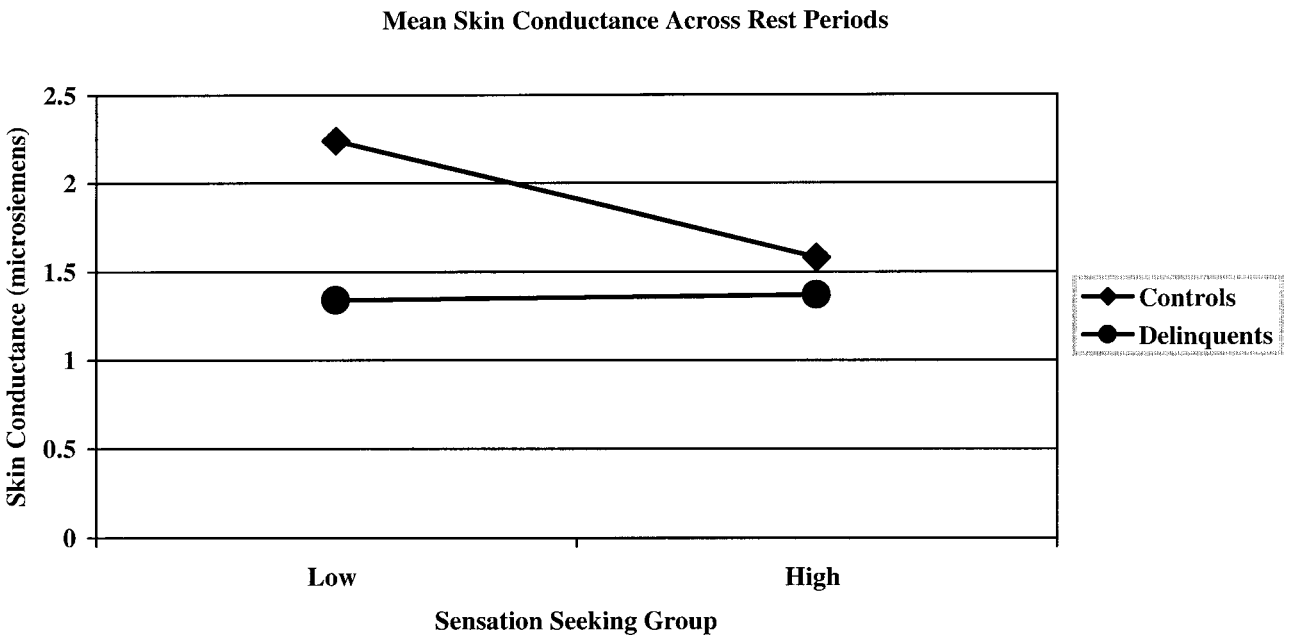

Fig. 1. Graphic representation of interaction between sensation seeking and delinquency on mean skin conductance level averaged across rest periods, controlling for race.

there is no main effect for sensation seeking, $F(1, 200) = 0.08$, $p = .773$, antisocial behavior, $F(1, 200) = 0.61$, $p = .437$, or race $F(1, 200) = 0.22$, $p = .643$, and there is no significant interaction between sensation seeking and antisocial status $F(1, 200) = 1.75$, $p = .187$.

Psychosocial Variables

While both delinquent groups had low skin conductance arousal, high sensation seeking controls were also low in skin conductance arousal. Given that this group appears to have two risk factors for delinquency, but does not become delinquent, analyses were conducted to see if high sensation seeking controls could be distinguished from their seriously delinquent counterparts on measures of IQ, impulsivity, and socioeconomic status. Within the high sensation seeking group, controls had significantly higher socioeconomic status scores, $F(1, 124) = 4.77$, $p = .031$, significantly less impulsivity, $F(1, 125) = 8.11$, $p = .005$, and significantly higher IQ, $F(1, 125) = 5.48$, $p = .021$ than the serious delinquents, when race was controlled. Within the low sensation seeking group controls also had higher IQs than the serious delinquent group, $F(1, 74) = 12.51$, $p = .001$, but they did not have higher socioeconomic status scores than delinquents, $F(1, 73) = 2.99$, $p = .088$, and were not less impulsive than delinquents, $F(1, 74) = 0.83$, $p = .365$, when race was controlled. Means and standard deviations are reported in Tables III and IV.

Protective Factors

Given that the results indicate that IQ, Socioeconomic status, and impulsivity may, in part, explain differences between the high sensation seeking delinquents and controls, these variables were further tested in 2×2 ANCOVAs to explore their potential as protective factors. Interactions were not significant for any of the variables: IQ $F(1, 200) = 1.44$, $p = .232$; Socioeconomic status

Table III. Statistical Differences Between Delinquents and Controls Within the High Sensation Seeking Groups on Possible Explanatory Factors, Controlling for Race

	M	*SD*	*N*	Significance
Impulsivity				
Delinquents	4.67	1.53	92	$p = .005$
Controls	3.92	1.59	36	
Full IQ				
Delinquents	87.40	17.05	92	$p = .021$
Controls	97.81	16.84	36	
Socioeconomic status scores				
Delinquents	33.45	13.04	91	$p = .031$
Controls	40.00	13.35	36	

Table IV. Statistical Differences Between Delinquents and Controls Within the Low Sensation Seeking Groups on Possible Explanatory Factors, Controlling for Race

	M	*SD*	*N*	Significance
Impulsivity				
Delinquents	3.79	1.64	47	$p = .365$
Controls	3.37	1.63	30	
Full IQ				
Delinquents	85.53	16.27	47	$p = .001$
Controls	102.83	15.66	30	
Socioeconomic status scores				
Delinquents	31.94	12.73	47	$p = .088$
Controls	39.41	11.30	29	

$F(1, 198) = 0.020$, $p = .886$; impulsivity $F(1, 200) = 0.413$, $p = .521$.

DISCUSSION

Results from this study indicate a main effect for delinquency status such that both delinquent groups had significantly lower skin conductance. This finding supports previous findings in antisocial populations (Raine, 1993). Likewise, as would be predicted theoretically, there was a strong effect for high sensation seekers to have low arousal regardless of antisocial status. It is important to note that the participants in this study were tested at an age when both antisocial conduct, as well as sensation seeking, are at their highest (Eysenck, Pearson, Easting, & Allsopp, 1985; Harpur & Hare, 1994), which may have increased the likelihood of finding effects for both of these variables. Results from this study did not directly support the hypothesis that high sensation seeking delinquents would exhibit the lowest levels of skin conductance at rest. Although this group was low in skin conductance, the high sensation seeking nondelinquent individuals were equally as low, as were the low sensation seeking delinquents.

Although the analyses did result in a significant interaction, this was not the interaction predicted from the literature. Examining the means on skin conductance levels across the two rest periods, it is evident that the most distinctive group is not the high sensation seeking antisocial group as predicted, but rather the low sensation seeking controls. It is possible therefore, that this group is characterized by excessive emotionality resulting in abnormally high skin conductance levels rather than the other groups representing abnormally low skin conductance values. This possibility was explored by examining negative emotionality immediately prior to psychophysiological data collection. No differences between groups existed on the state level of negative emotionality. Therefore, while it remains possible that the low sensation seeking control group is abnormally high in skin conductance, this does not appear to be due to excessive negative emotionality or anxiety. Given this finding, and the literature on sensation seeking and antisocial behavior, it is likely that the remaining groups (high sensation seekers and antisocials) are pathologically low on skin conductance and that the control group represents a normal level of arousal rather than being pathologically elevated.

Additionally, several psychosocial factors were explored in terms of their value in explaining the relationship between sensation seeking and delinquency. Although IQ and socioeconomic status were higher, and impulsivity lower, among participants who were high in sensation seeking but did not engage in delinquent behavior, these variables do not technically fit the criteria for protective factors, at least as defined by Rutter (1990). The high sensation seeking controls do not appear to be protected by statistically higher IQ and SES or lower impulsivity than all other groups. However, the relationship between these variables and delinquent behavior may explain why some adolescents who are high in sensation seeking go on to become antisocial. Even though sensation seeking has been related to delinquent acts, this expression may be influenced by other psychosocial variables as well.

Although low skin conductance arousal has been hypothesized to relate to antisocial behavior, it is clear that sensation seeking does not mediate this relationship in all cases as there is clearly a group of antisocial subjects with low SCL arousal who are not sensation seekers. One possibility is that each delinquent group (high and low sensation seekers) may be described separately by existing theories explaining why psychopaths or antisocials may have low arousal (Herpertz et al., 2001). One theory, as presented here, is that antisocial subjects have low arousal, which causes them to engage in sensation seeking behavior in an effort to raise arousal levels (Quay, 1965). This would describe only the high sensation seeking delinquent group. The second theory suggests that low arousal represents a state of fearlessness, which leads to antisocial behavior through the inability to learn from punishment (Arnett, 1997). These theories may help to explain why the two groups of antisocial subjects (high and low sensation seekers) may share the common trait of low arousal. However, the idea that each antisocial group represents one of these theories (high sensation seeking and fearlessness) has not been directly tested in this study and should be explored further before any firm conclusions can be drawn.

Another possible explanation for the relationship between sensation seeking and skin conductance in this sample is the specific nature of the sensation seeking measure

used. Most past studies have attempted to relate general measures of sensation seeking and various subscales of the general measure to electrodermal arousal; however, this study used a more isolated measure of sensation seeking, that excluded impulsivity from the scale. Impulsivity was correlated with sensation seeking in this sample, as would be predicted; however, there was no relationship between impulsivity and skin conductance in this sample. Perhaps only the most specific measure of sensation seeking behavior relates to skin conductance, and the inclusion of other factors in the sensation seeking scales used by other groups may explain the discrepancies with the results reported here. Also mentioned previously is that the participants were tested at an age when both sensation seeking and antisocial behavior are likely to be at their highest. In past research, a correlation was found between sensation seeking and skin conductance arousal at rest, but only in young females and not older females (Plouffe & Stelmack, 1986). Thus, the current results may be specific only to the adolescent sample used here and may not generalize across the age range.

The possibility should also be considered that low arousal does not necessarily lead to antisocial behavior, and may actually be a consequence of it. The current study is unable to determine the sequential nature of the relationship as the psychophysiological assessment was not made prior to the antisocial and delinquent behavior. Although correlational findings cannot clarify this issue, past research of a longitudinal nature has shown both low arousal, and sensation seeking as early as age 3 years, to predict later aggressive and antisocial behavior, thus suggesting that it is possible that these two factors represent potentially causal mechanisms (Raine et al., 1990, 1998).

In conclusion, results from this study support the hypothesis that skin conductance arousal is low in both sensation seekers and delinquent adolescents. No evidence is found to suggest that the presence of both of these factors relates to especially low skin conductance levels. Explanations for the nature of the interaction, or for the high skin conductance levels of the low sensation seeking nondelinquents remain inconclusive.

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